

Current Progress in the Development and Application of a Taiwan-Endemic Edible Fungus *Antrodia Cinnamomea*: A Mini Review

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Abstract

Edible fungi have become veritable edible and medicinal mushrooms, both for medicinal and edible purposes. Breakthroughs in artificial cultivation techniques and genomic research have profoundly enriched our understanding of edible fungi. This article reviews the current progress in the few different applications of *Antrodia Cinnamomea*, a Taiwan-endemic edible fungus that has garnered widespread attention in recent years. For example, this systematic review focuses on the progresses in various aspects, such as identification of its chemical components, artificial cultivation, and its applications in anti-aging, anti-tumor, liver protection, alcohol detoxification, and health beverages.

Keywords: *Antrodia Cinnamomea*; Edible Fungus; Chemical Components; Anti-tumor; Liver Protection; Alcohol Detoxification.

Introduction

Edible fungi have become the fifth largest crop in mainland China and where has become a veritable edible and medicinal fungi country. With the advancing progress of molecular systematic research, the understanding of these important edible species, such as *Ganoderma lucidum*, black fungus, hairy fungus, and *Cordyceps sinensis*, has become more comprehensive and clearly. The most difficult-to-cultivate species such as *Cordyceps sinensis*, *Morchella oleracea*, and *Boletus edulis* have been artificially cultivated worldwide. The genome analysis of most common edible and medicinal fungi has been completed. The basic research promotes the fast development of the edible and medicinal fungi cultivate manufacture, and at the same time, the development of the cultivate industry raises more scientific questions for basic research to answer soon [1]. In recent years, the edible fungus *Antrodia cinnamomea*, which original appeared in Taiwan, has attracted widespread attention due to its unique characteristics and properties. It was named because it was first discovered to be parasitic on the wood of the first-class broad-leaved tree *Antrodia cinnamomea* unique to Taiwan. *Antrodia cinnamomea*, also known as many different nicknames, as possible in Chinese, but only one English name of *Antrodia cinnamomea*. Well-known

Antrodia cinnamomea has a fragrant smell, a pungent and bitter taste, and has a harsh growth environment. It is saprophytic in the hollow part of the trunk of the Taiwan-specific tree species *Antrodia cinnamomea* or on the dark and moist trunk surface of the dead and fallen *Antrodia cinnamomea* tree. Due to its host specificity, slow growth and difficulty in artificial cultivation, *Antrodia cinnamomea* is extremely rare and expensive, and is known as the “forest ruby”. As a medicinal fungus unique from Taiwan, *Antrodia cinnamomea* is generally believed to have the properties of detoxification, analgesia, blood pressure reduction, treatment of liver inflammation and anti-cancer, which makes its price high and very expensive, and it is known as a precious medicinal edible fungus [2].

Application Progress of *Antrodia Cinnamomea* in Many Aspects

Artificial Cultivation Methods of *Antrodia Cinnamomea*

Due to its high price, and with the gradual depletion of *Antrodia cinnamomea* wild resources and its good health functions, the price of *Antrodia cinnamomea* has continued to rise, which has promoted the development and exploration of artificial cultivation

technology. At present, there are four main artificial cultivation methods, namely basswood cultivation method, solid culture method, liquid fermentation method, and vessel culture method. The basswood cultivation method has made breakthroughs in recent years. Cultivating *Antrodia cinnamomea* using basswood, the original host, as a culture medium has high cultivation costs. In recent years, basswood cultivation methods have also been developed using applewood, fir, and Fujian native small-leaved red-heart camphor basswood as substrates [3-6] have developed a method for cultivating *Antrodia cinnamomea* fruiting bodies using applewood, which includes cultivating *Antrodia cinnamomea* in a liquid seed culture medium or a solid seed culture medium under conditions suitable for *Antrodia cinnamomea* growth to obtain liquid or solid *Antrodia cinnamomea* seeds; soaking and cleaning the applewood piles, putting them into polypropylene bags, sealing and tying them tightly for sterilization; opening the bags containing applewood under a sterile environment, inoculating solid or liquid *Antrodia cinnamomea* seeds, and sealing and tying them tightly; dark culturing the inoculated bags to complete nutritional growth process; removing the bags for culturing, and harvesting the *Antrodia cinnamomea* fruiting bodies when they grow to a size of more than 2 cm, completing the plant growth procedure management. The raw materials of the carrot culture medium used include of: filtrate filtered after boiling carrots in water, glucose, agar, and the remaining water; the raw materials of the liquid seed culture medium used include malt juice with a solid content of 5% (W/V); and the cultivation medium is applewood. This method is simple to operate, has a relatively short cultivation cycle, a wide range of raw materials, and is low in cost [3]. Huang Axian has researched and invented a basswood cultivation method for *Antrodia cinnamomea*. In a sterile operating environment, the completely sterilized local Fujian small-leaf red-heart camphor basswood is soaked in a natural *Antrodia cinnamomea* fungus to ferment and produce *Antrodia cinnamomea* liquid. After removing the basswood, it is placed in a cool, humid and dark culture room. When the *Antrodia cinnamomea* fruiting bodies grow to 1-1.5 cm on the basswood surface, they are harvested. After harvesting, a 1-2 cm thick section is cut off from the basswood surface. After complete sterilization, the basswood surface is sprayed with *Antrodia cinnamomea* liquid again, and then the above steps are repeated for the next round of inoculation until the basswood is free of camphor oil smell. Extracts of these Chinese herbs (coptis root, lotus leaf, dandelion, knotweed, wormwood), corn starch, protein and water are used as traditional Chinese medicine additives in the fermentation process of natural *Antrodia cinnamomea*, so that the *Antrodia cinnamomea* fruiting bodies obtained by basswood cultivation method have the same composition as wild *Antrodia cinnamomea*, and can completely replace wild *Antrodia cinnamomea* in terms of appearance, sound, bitterness and composition [4,5]. Has researched and invented a method for artificially cultivating white *Antrodia cinnamomea*, which includes the steps of aseptic sampling, mushroom body slicing, rejuvenation and purification,

culture medium preparation, inoculation culture, collection and packaging. Through the above technical solution, the problem that the current artificial cultivation technology cannot cultivate white *Antrodia cinnamomea* has been solved, and the content of total triterpenes and polysaccharides in *Antrodia cinnamomea* has been increased. The white *Antrodia cinnamomea* cultivated by converting the bitter buckwheat culture medium has successfully removed the toxins originally contained. In addition, this technology can be used for quantitative production of white *Antrodia cinnamomea*. Pure white *Antrodia cinnamomea* can be cultivated through multiple purification and rejuvenation processes. By controlling time and temperature and humidity, the mycelium of *Antrodia cinnamomea* is aggregated into blocks, which greatly increases the content of total triterpenes in *Antrodia cinnamomea* and the polysaccharide content is also increased to 14.8% [5].

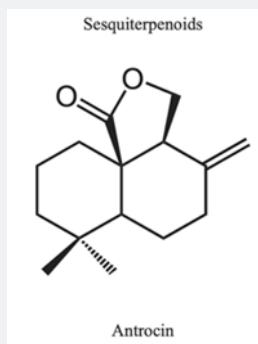
Progress of Chemical Component Identification of *Antrodia Cinnamomea*

Antrodia Cinnamomea (Taiwanofungus camphoratus) originates from a rare and endemic fungus in Taiwan. Its chemical composition is exceptionally complex, comprising a mixture of natural organic compounds. Numerous studies over the past decade have identified several major classes of compounds in *Antrodia Cinnamomea*, which can be broadly categorized into the following five groups: 1. Sesquiterpenoids: antrocin (Scheme 1,2). Triterpenoids: ergostane and lanostane. Ergostane triterpenoids include antcin A, antcin B, antcin C, antcin H, antcin K, methyl antcinate A, and methyl antcinate B, which are the primary active ingredients in *Antrodia Cinnamomea*; and lanostane triterpenoids: eburicoic acid, dehydroeburicoic acid, and dehydrosulphurenic acid (Scheme 2,3). Furan or pyrrole compounds with a five-ring structure: Antrocin C (Scheme 3,4). Benzene ring compounds (Benzenoids): Antrocamphin A, 2,3,5-trimethoxy-4-cresol (TMC), 4,7-dimethoxy-5-methyl-1,3-benzodioxole (DMB), 2,4-Dimethoxy-6-methylbenzene-1,3-diol (DMD). 5. Ubiquinone compounds as shown in (Scheme 5) [6].

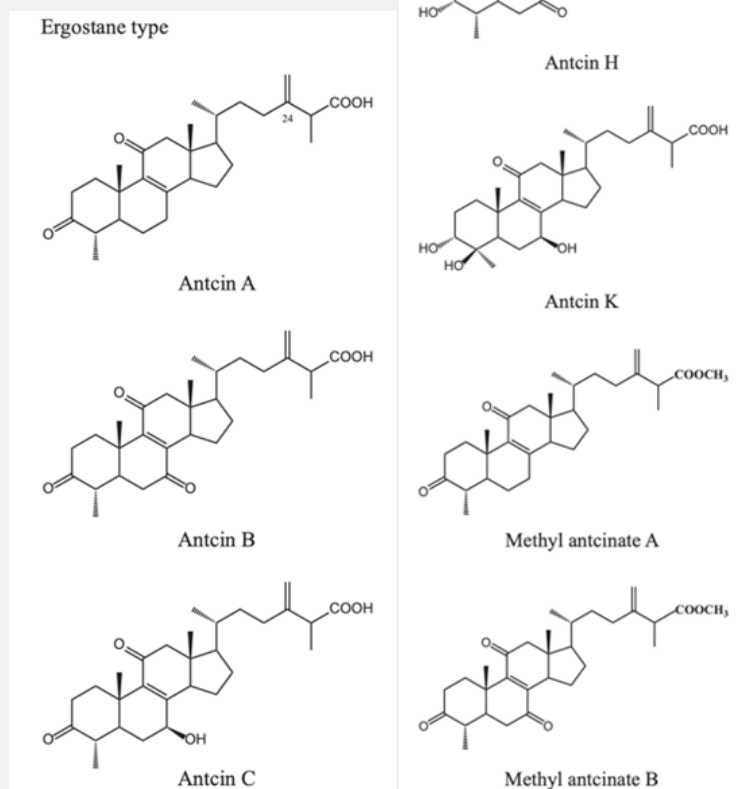
Studies have shown that among the five major categories of active ingredients in medicinal fungi such as *Antrodia cinnamomea*, triterpenoids are an important part. Triterpenoids refer to compounds composed of 29-31 carbon atoms formed by the linkage of 6 isoprenes. Steroids with 31 carbon atoms and 29 carbon atoms found in the mycelium and fruiting body of *Antrodia cinnamomea* share most of the biosynthetic pathways. Both are biosynthesized from the acetate/mevalonate pathway in the cytoplasm and endoplasmic filaments of plant cells. More than 160 compounds have been identified from *Antrodia cinnamomea*. Among them, 49 are sterols. Sterols are the main components of the fruiting body of *Antrodia cinnamomea*, accounting for about 60% of the dry weight [2]. The most studied triterpenoids and sterol terpenes are tetracyclic derivatives. Triterpenoids have received considerable attention in phytochemistry and pharmaceutical industries. In addition, other compounds have also been isolated

and purified. Liu Shengyong et al. invented a Antrodia cinnamomea compound for alleviating physiological fatigue, especially 4-hydroxy-2,3-dimethoxy-6-methyl-5 (3,7,11-trimethyl-2,6,10-dodecatriene)-2-cyclohexenone (4-hydroxy-2,3-dimethoxy-6-methyl-5 (3,7,11-trimethyl-dodeca-2,6,10-trienyl)-cyclohex-2-enone) isolated from Antrodia cinnamomea extract can

effectively alleviate physiological fatigue. In the present invention, supplementing the a forementioned compound immediately after high-intensity exhaustion exercise at 80% of maximum oxygen uptake can promote the metabolism of creatine kinase and blood ammonia in the body and help restore their concentrations, thereby achieving the effect of alleviating physiological fatigue [7].

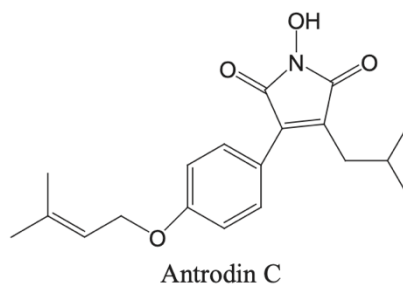


Scheme 1: Sesquiterpenoids.



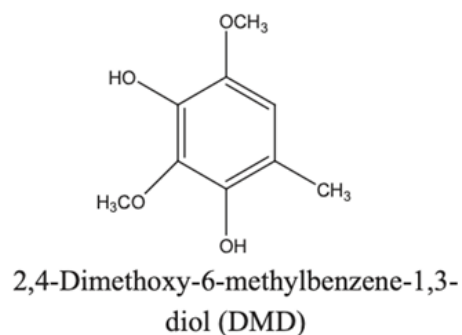
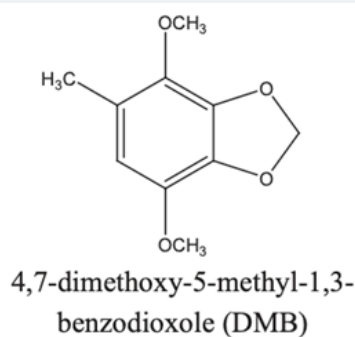
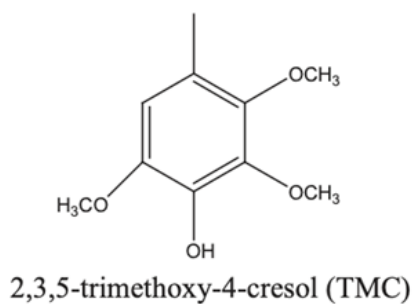
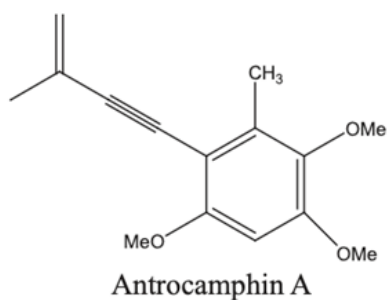
Scheme 2: Triterpenoids.

Furan or pyrrole



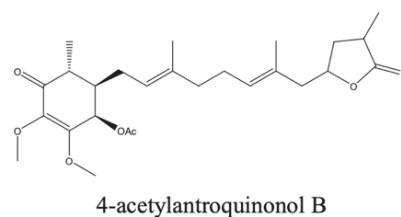
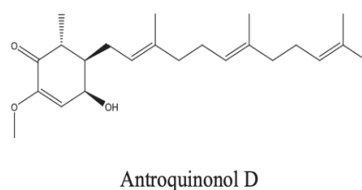
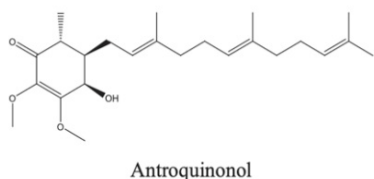
Scheme 3: Furan or pyrrole compounds.

Benzenoids

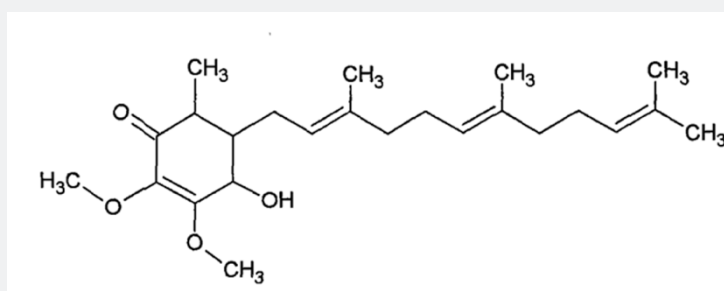


Scheme 4: Benzene ring compounds.

Ubiquinones



Scheme 5: Ubiquinone compounds.



Scheme 6: Cyclohexenone compound.

Among the active ingredients of *Antrodia cinnamomea*, triterpenoid compounds are the main effective ingredients and play an important role in use. Many people have explored different methods to increase their content. For example, Ji Yanbin et al. proposed a method for refining triterpenoids from *Antrodia cinnamomea*. *Antrodia cinnamomea* undergoes pretreatment, supercritical CO₂ extraction of triterpenoids, ultrasonic extraction of triterpenoids, and vacuum distillation to obtain a crude triterpenoid extract concentrate. This extract is then extracted with ethyl acetate to obtain a refined triterpenoid extract and then vacuum distilled to obtain a refined triterpenoid extract. Compared with existing technologies, this method is simpler to operate and more effective, and the overall operating conditions are mild, fully preserving the physiological activity of triterpenoids. Chloroform is used to dissolve *Antrodia cinnamomea* powder, avoiding the effects of chloroform on the product. The residue after supercritical CO₂ extraction is then subjected to ultrasonic extraction, allowing the triterpenoids in *Antrodia cinnamomea* to be completely extracted, thereby improving the extraction yield of triterpenoids [8-10].

Applications Progress of *Antrodia Cinnamomea* for Anti-Aging

Human aging is a natural phenomenon and an inevitable biological process. All living organisms are multi-tissue/organ systems. Research has shown that the aging process affects each organ differently. Some organs undergo regular renewal, while others do not. For example, cells in the skin and intestines undergo constant renewal, while cells in the heart and brain undergo very few. Skin aging is caused by both intrinsic and extrinsic factors. Intrinsic aging is a genetically determined degenerative aging process that leads to fine lines, dryness, fine lines, and gradual skin atrophy. External factors include air pollution, smoking, malnutrition, and ultraviolet radiation. Recent studies have shown that diabetes can contribute to skin aging. Therefore, we evaluated the anti-aging activity of antrodia acid using in vitro high-glucose induction assays and nematode experiments. The results showed that antrodia acid M was the most active antrodia acid, demonstrating high activity in inhibiting high-glucose-induced aging and growth arrest. Antrodia acid M significantly increased the lifespan of nematodes and protected them from

high-glucose-induced oxidative damage. These research results suggest that antrodia acid M can be used as a preventive reagent and anti-aging agent for age-related diseases [2].

Application progress of *Antrodia Cinnamomea* in Liver Protection and Hangover Relief

At present, with the continuous improvement of people's living standards, the number of people drinking alcohol has increased significantly, and the incidence of alcohol-induced liver diseases has also increased considerably [11]. Many studies have shown that if a person drinks alcohol for a long time, his liver will be severely affected or partially damaged, causing a series of alcohol-related liver diseases [12]. Liver dysfunction will cause symptoms such as fatigue, loss of appetite, and dull pain in the liver area, and will gradually develop into alcoholic hepatitis, with inflammation and necrosis of liver cells, and significant increases in blood indicators such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST). If it continues to develop, it may lead to liver fibrosis, abnormal proliferation of fibrous connective tissue in the liver, and destruction of the normal structure of the liver. In more serious cases, some patients will eventually develop cirrhosis or even liver cancer, which seriously threatens their life and health. Unfortunately, in terms of clinical treatment, there is currently no specific drug that can safely and effectively reverse the process of alcoholic liver damage. Based on this, it is urgent to find effective preventive drugs. As a rare medicinal fungus in Taiwan, the treasure island of our motherland, *Antrodia cinnamomea* has shown great potential in the field of hangover relief and liver protection. According to literature records and folk legends, a long time ago, the indigenous people of Taiwan discovered the medicinal value of *Antrodia cinnamomea* through their keen observation of nature and long-term practice and widely used it in the prevention and treatment of various diseases. In daily life, the indigenous people would use *Antrodia cinnamomea* to relieve the discomfort symptoms after drinking, which played a role in quickly sobering up; when encountering emergencies such as food poisoning, *Antrodia cinnamomea* is their natural detoxification medicine; when facing difficult diseases such as liver disease, *Antrodia cinnamomea* also showed a certain therapeutic effect [13].

From the research of modern pharmacology, it is known that *Antrodia cinnamomea* extracts and their active ingredients have a wide range of biological activities, including liver protection, anti-inflammatory, immunomodulatory, antioxidant and neuroprotective effects [14,15] invented a health product for hangover relief, which uses *Antrodia cinnamomea* solid powder with some Chinese herbal medicines, *Hovenia dulcis*, *Pueraria* root and *Pueraria* flower, soaked in 10 times the amount of 65% ethanol for about 30 minutes, heated in a water bath and refluxed for about 2 hours, and then added 8 times the amount of 65% ethanol to the residue, refluxed for about 2 hours, combined with the filtrate, concentrated, and then added *Antrodia cinnamomea* solid powder and corn peptide, mixed evenly, and pressed into tablets. The invented health product for hangover relief has been shown to promote the absorption and decomposition of alcohol in the body, has the effect of sobering up and hangover relief, and has a good effect of protecting the liver.

Similarly [16], also invented a method for preparing *Antrodia cinnamomea* extract for anti-cancer and liver protection. The method first ultra finely grinds the *Antrodia cinnamomea* extract, then treats it at low temperature, and finally breaks the wall with a laser, which can effectively improve the utilization rate of triterpenes and polysaccharides in *Antrodia cinnamomea*, thereby improving the anti-cancer and liver protection effects of the extract [17] also invented and disclosed a drug for protecting liver and sobering up, which is made of Chinese herbal medicines such as ginseng, kudzu flower, notoginseng, *acanthopanax*, kudzu root powder and extract powders of *Antrodia cinnamomea*, mulberry and *Agaricus blazei*, grape tea polyphenols, starch and edible gum. These powders are mixed into a powder for oral administration. Tests show that it has the effects of promoting spirit and eliminating body toxically accumulation, reducing swelling and distension, and is suitable for symptoms such as flank pain, yellow face and swelling, and abdominal mass after drinking. After the human body consumes a large amount of alcohol, the ginseng, kudzu flower, kudzu root, notoginseng and *acanthopanax* in the drug can decompose the alcohol concentration and relieve symptoms such as dizziness and vomiting caused by excessive alcohol concentration.

Anti-tumor Applications Progress of *Antrodia Cinnamomea*

Antrodia Cinnamomea contains many physiologically active ingredients, such as polysaccharides, triterpenes, superoxide dismutase, adenosine, proteins (including immune proteins), vitamins, trace elements, nucleic acids, lectins, amino acids, sterols, cellulose, and blood pressure-stabilizing substances. However, the most important physiologically active ingredients are polysaccharides (β -D-glucans) and triterpenes. Both wild and cultivated fruiting bodies, mycelium, and liquid fermentation products of *Antrodia Cinnamomea* are rich in physiologically active substances and have virtually no toxic side effects. They

can be processed into health foods and pharmaceuticals with anti-tumor, anti-hepatitis, liver protection, immunity-enhancing, anti-aging, and anti-inflammatory effects, possessing great development value and application prospects. Approximately 11 triterpenes have been identified in *Antrodia Cinnamomea* fruiting body extracts, and 5 in mycelium. Among these are the triterpenes Zhankuic acid A, B, and C isolated from the fruiting bodies, and two newly discovered compounds with ergostane as their backbone, Zhankuic acid D, Zhankuic acid E and triterpenoid compounds with ergostane as the skeleton, Antcin A, Antcin B, Antcin C, Antcin E and Antcin F, which are also isolated from the fruiting body, have different anticancer effects. Therefore, we proposed a preparation and application of a tumor cell inhibitor based on *Antrodia cinnamomea* extract.

Wang Shengyang's team [2] proved ten years ago that Zhankuic acid A can exhibit anti-inflammatory activity, and they recently found that glucocorticoid treatment induces the expression of microRNA-708 (miR-708) in ovarian cancer cells, thereby inhibiting tumor cell metastasis and tumor cell proliferation [18 Carcinogenesis, 40(2): 335-348] Carcinogenesis. Furthermore, they found that treatment of human breast cancer cells MCF-7 and MDA-MB-231 with the synthetic glucocorticoid dexamethasone (DEX) or the natural glucocorticoid analog Antcin A (ATA) significantly increased miR-708 expression through glucocorticoid receptor α (GR α) activation, effectively inhibiting cancer cell proliferation, cell cycle progression, tumor stem cell expression, and metastasis. Human breast cancer cell xenograft models demonstrated that treatment with GR agonists significantly inhibited tumor growth, tumor weight, and tumor volume. These findings suggest that GR agonists, which induce miR-708 expression and inhibit downstream NF- κ B signaling, could represent a novel therapeutic approach for breast cancer. Recent research also suggests that *Antrodia cinnamomea*, a unique compound called anthelmintic acid A, regulates epithelial-mesenchymal transition (EMT) in human breast cancer cells in vitro, inhibiting cancer cell migration and invasion [18 Plant Med, 85: 755-765] Human breast cancer cell lines MCF-7 and MDA-MB-231 were incubated with anthelmintic acid A for 24 hours and assayed for wound healing, trans-pore invasion, Western blotting, q-PCR, F-actin staining, and immunofluorescence. The results showed that anthelmintic acid A significantly blocked the EMT process, as demonstrated by inhibition of E-cadherin and occludin, and by reduction of N-cadherin and vimentin through inhibition of its transcriptional repressor, ZEB1. *Antrodia cinnamomea* also induced miR-200c, which is involved in p53 transcriptional activation, as confirmed by its failure to induce miR-200c or inhibit ZEB1 activity in p53-suppressed cells. Further in vitro wound healing and trans-pore invasion assays support that *Antrodia cinnamomea* acid A can inhibit the metastasis and invasion potential of breast cancer cells, and this effect may be associated with the induced phenotypic regulation. All studies have shown that *Antrodia cinnamomea* acid A has the potential

to be a leading natural compound for the development of anti-metastatic drugs for the treatment of breast cancer [19] obtained tumor cell inhibitors from *Antrodia cinnamomea* extracts, which have good anti-tumor effects. In addition, *Antrodia cinnamomea* fruiting bodies, mycelium and their liquid culture can be made into health foods and medicines with anti-hepatitis, liver protection, immune regulation, anti-aging and anti-inflammatory effects, which have great development value and application prospects [19]. Tumor immunotherapy is a treatment method that controls and eliminates tumors by restarting and maintaining the tumor-immune cycle and restoring the body's normal anti-tumor immune response. The main ways of tumor immunotherapy arise from two actions: one is to target tumor cells, and the other is to activate immune cells. Target tumor cells usually use bacterial toxins, oncolytic viruses and monoclonal antibodies to eliminate tumor cells, but the first two have high toxicity and uncontrollability. Therefore, monoclonal antibodies are currently commonly used technique. Immune cell activation typically involves the use of cytokines, tumor antigens, immune system agonists, and immune checkpoint inhibitors to activate the immune system and kill tumors.

Antrocin was isolated from *Antrodia camphorata* (*Antrodia camphorata*) in Taiwan in 1994 by researcher Hung-Chen Chiang and his collaborators. Studies have shown that Antrocin exhibits selective inhibitory activity against human metastatic breast cancer and non-small cell lung cancer cell lines. However, research evidence and mechanism for its use in tumor immunotherapy is currently lacking. Yang Zhen et al. invented and prepared a *Antrodia cinnamomea* oleracea and its micro-nanoparticle preparation and used it in tumor treatment trials as a tumor immunotherapy drug. The experiment confirmed that *Antrodia cinnamomea* oleracea micro-nanoparticles can induce the body's anti-tumor immune response, increase the number and activity of immune cells such as CD8⁺ cells, CD4⁺ cells, CD3⁺ cells, B220⁺ cells, neutrophils, macrophages, NK1⁺ cells and dendritic cells, inhibit tumor growth, reduce tumor size. This drug is considered also safe, reliable and stable [20]. Liu Shengyong et al. proposed a new application of a novel compound, 4-hydroxy-2,3-dimethoxy-6-methyl-5(3,7,11-trimethyl-2,6,10-dodecatriene)-2-cyclohexenone, which was obtained by separation and purification from *Antrodia cinnamomea* extract. The cyclohexenone compound can be used to inhibit the growth of skin cancer cells and can also be used in pharmaceutical compositions for inhibiting the growth of skin cancer cells to play a synergistic role as shown in (Scheme 6) [21].

Li Shiqiang and others invented a Chinese herbal medicine composition for anti-uterine fibroids, which uses *Antrodia cinnamomea* as the main ingredient and is combined with other small amounts of Chinese herbal medicines such as *Astragalus* and *Leonurus*. The extract of this Chinese herbal medicine composition can be used to prevent and improve the symptoms of uterine fibroids and resist the growth of uterine fibroids [9].

In addition, Chen Helong and Xie Zhongjun jointly studied and proposed a processing technology for anti-tumor biological Chinese medicine preparations. The raw materials include *Antrodia cinnamomea*, *Geckos*, *Panax notoginseng*, *Dioscorea bulbifera*, *Ganoderma lucidum*, *Bupleurum chinense*, *Aucklandia lappa*, *Scutellaria barbata* and *Ligustrum lucidum*. An oral liquid was prepared through the proposed process. The oral liquid can regulate the environment that causes cancer in the body, reduce the substances that cause normal cells to become cancerous, correct cancer cells, absorb and shrink tumors in the body, and prevent cancer metastasis and recurrence. The effect is quietly obvious [22].

Progress of Other Pharmacological Activities and Applications

In addition, *Antrodia cinnamomea* exhibits a variety of other pharmacological activities: **Hypoglycemic Effects:** *Antrodia cinnamomea* polysaccharides contain components with insulin-like properties, which not only supplement insufficient insulin secretion but also promote the restoration of pancreatic function. *Antrodia cinnamomea* also has multiple protective effects on the cardiovascular system. It can lower blood cholesterol and low-density lipoprotein (LDL) levels. Its adenosine content can reduce platelet aggregation and prevent thrombosis. *Antrodia cinnamomea* can repair damaged endothelial cells, increase vascular elasticity, dissolve plaque, and thus reduce the risk of arteriosclerosis. These effects make *Antrodia cinnamomea* useful in the adjunctive treatment of various cardiovascular and cerebrovascular diseases, such as hypertension, hypotension, arteriosclerosis, thrombosis, myocardial infarction, stroke, and angina pectoris. **Anti-inflammatory and Analgesic Effects:** *Antrodia cinnamomea* polysaccharides and triterpenoids have anti-inflammatory and analgesic properties, effectively treating and alleviating various pains caused by vascular problems, such as low back pain, shoulder pain, rheumatic pain, and menstrual pain. **Bone Protection:** The ergosterol in *Antrodia cinnamomea* is a precursor to vitamin D, promoting calcium absorption and preventing osteoporosis. **Kidney Protection:** Studies have shown that the triterpenes and polysaccharides in *Antrodia cinnamomea* can effectively improve various kidney-related conditions, such as nephritis, proteinuria, and uremia [23-25].

Conclusion

With the decline of wild *Antrodia cinnamomea* resources and the challenge of meeting human needs, the rise of artificial cultivation technology is an effective way to address resource shortages. The development of artificial cultivation technology and the scientific identification of its chemical components have gradually clarified the physicochemical fundamentals of *Antrodia cinnamomea* as a unique medicinal fungus, which possesses multiple biological activities and broad application prospects. Its detoxification, liver protection, anti-tumor, and anti-aging

effects have been preliminarily clinically validated. However, further research is needed to understand its mechanism of action and clinical manifestations at the molecular biological level. With the deepening of research and the expansion of its application areas, *Antrodia cinnamomea* and other compound pharmaceuticals, health supplements, and oral liquids have already played a significant role in various fields, including healthcare. Their widespread application is particularly evident in liver protection and detoxification, contributing to human health as a "Taiwanese unique calling card." Future research should focus on multidisciplinary collaboration, integrating modern scientific analytical techniques with the clinical application of traditional medicine to conduct precise pharmacological and medicinal research, fully exploring the potential of this unique and precious medicinal fungus. At the same time, it should also emphasize resource conservation and sustainable development and utilization, providing high-quality services to further improve human health and quality of daily life.

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